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(71) Applicant: SAMSUNG ELECTRONICS CO., LTD. [KR/KR]; 416, Maetan-dong, Paldal-gu, Suwon-shi, Kyungki-do 442-370 (KR).

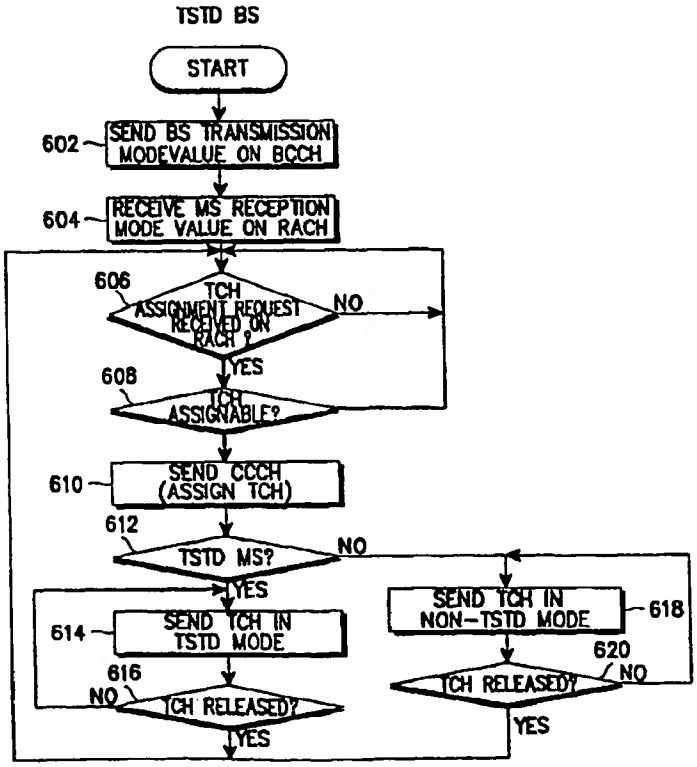
(72) Inventors: PARK JIN, Soo; 265-20, Sokchon-dong, Songpa-gu, Seoul 137-044 (KR). PARK, Su, Won; 1662-9, Shillim 8-dong, Kwanak-gu, Seoul 151-018 (KR). YOON, Soon, Young; 165, Karak-dong, Songpa-gu, Seoul 138-160 (KR). AHN, Jae, Min; Puleun Samho Apt. #109-303, Irwonpon-dong, Kangnam-gu, Seoul 135-239 (KR).

(74) Agent: LEE, Keon, Joo; Mihwa Building, 110-2, Myon-gryun-dong, 4-ga, Chongro-gu, Seoul 110-524 (KR).

(54) Title: TIME-SWITCHED TRANSMISSION DIVERSITY (TSTD) DEVICE AND CONTROLLING METHOD THEREOF IN MOBILE COMMUNICATION SYSTEM

(57) Abstract

There is provided a transmission diversity controlling method in a mobile communication system including a base station which transmits forward common and dedicated channel data through at least two antennas with transmission diversity. The base station sends a message indicating a TSTD (Tune-Switched Transmission Diversity)/non TSTD transmission mode through an antenna to a plurality of mobile stations in the coverage area of the base station. Then, each mobile station analyses the message received from the base station and sets its reception mode to a TSTD/non-TSTD mode according to the transmission mode.



TIME-SWITCHED TRANSMISSION DIVERSITY (TSTD) DEVICE AND CONTROLLING METHOD THEREOF IN MOBILE COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to the field of communication systems, and particularly to a transmitting/receiving device with a time-switched transmission diversity function and a controlling method thereof in a mobile communication system.(For better understanding of the present invention, see Korea Application No. 1998-5526, Korea Application No. 1998-17277, and Korea Application No. 1998-17280)

2. Description of the Related Art

A base station (BS) and a mobile station (MS) communicate data with each other through their single antennas in most mobile communication systems. When a signal-fading phenomenon occurs, a plurality of data groups are damaged, resulting in a serious degradation of communication quality. This problem can be solved by use of a transmission diversity scheme in which data is transmitted through at least two transmission antennas. That is, the transmission diversity scheme can increase data transmission/reception performance in a mobile communication system under a signal fading environment.

In addition to using a transmission diversity scheme, a reception diversity scheme can be utilized on the reverse link by installing a plurality of reception antennas in a BS so that the BS can receive a signal from an MS on a reverse link with good reception performance. On a forward link, the BS can transmit a signal to the MS through multiple antennas. For communication with the BS, the MS may employ one of these approaches; a transmission diversity scheme using a plurality of transmission antennas with a single reception antenna, a reception diversity scheme requiring a plurality of reception antennas, or a combination of the transmission and reception diversity schemes.

Reception diversity on the forward link, however, is not viable because the mobile terminal is small. That is, using a plurality of reception antennas for the mobile terminal results in a small diversity gain due to the limited distance between antennas. Furthermore, the mobile terminal should be equipped with separately procured devices for receiving forward link signals and transmitting reverse link signals through corresponding antennas. Therefore, for the reasons stated, the reception diversity scheme is disadvantageous in terms of the size and cost of the mobile terminal. Therefore, the transmission diversity scheme is generally used for the forward link in a base station.

SUMMARY OF THE INVENTION

The method of the present invention is generally referred to as time switched transmission diversity (TSTD) and is applied to signal transmissions on a forward link from a BS to an MS in a CDMA (Code Division Multiple Access) mobile communication system. The TSTD scheme increases transmission efficiency by transmitting signals through at least two antennas which are alternately switched in the BS. Since a TSTD transmitting/receiving device

increases device complexity as well as performance in comparison with a conventional single-antenna transmitting/receiving device, it is expected that the inventive TSTD device and a non-TSTD (i.e., prior art) device will coexist. Therefore, to ensure reliable TSTD transmission/reception, a BS and an MS should support a TSTD mode, and have controllers and controlling procedures for determining whether to use the TSTD mode prior to transmission/reception of user data and signalling data on a dedicated channel. The controlling procedures are necessary to allow a non-TSTD MS to compatibly communicate with a TSTD BS.

For a BS to transmit modulated data in a TSTD mode through at least two antennas and for an MS to receive the TSTD data from the BS, their operational modes should be set up. For proper operation, if the BS is to transmit data in the TSTD mode, the MS detects the transmission mode of the BS by analysing a message received from the BS and sets its reception mode to a TSTD or non-TSTD mode according to the detected transmission mode, for data reception.

It is therefore an object of the present invention to provide a device for communicating data between a BS and an MS which support TSTD as an optional or requisite function and a controlling method thereof.

Another object of the present invention is to provide a device for setting transmission/reception modes of a BS and an MS which support TSTD as an optional or requisite function and a controlling method thereof.

A further object of the present invention is to provide a device and method of estimating the channel status of TSTD signals received from a TSTD BS through a plurality of transmit antennas.

A still further object of the present invention is to provide a method of setting a TSTD mode between a BS and an MS which support TSTD as an optional or requisite function.

Still another object of the present invention is to provide a method of operating forward common and dedicated channels between a BS and an MS which are support TSTD as an optional function in a mobile communication system.

A yet another object of the present invention is to provide a device and method for operating forward common and dedicated channels in the case where BSs and MSs which support TSTD as an optional or requisite function coexist with Bss and MSs which do not support TSTD in a mobile communication system.

To achieve the above objects, there is provided a transmission diversity controlling method in a mobile communication system including a base station which transmits forward common and dedicated channel data through at least two antennas with transmission diversity. The base station sends a message indicating a TSTD/non-TSTD transmission mode through an antenna to a plurality of mobile stations in the coverage area of the base station. Then, each mobile station analyses the message received from the base station and sets its reception mode to a TSTD/non-TSTD mode according to the transmission mode.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with

reference to the attached drawings in which:

FIGs. 1A, 1B and 1C is an illustration describing a TSTD operation in a mobile communication system according to an embodiment of the present invention;

FIG. 2 is a block diagram of a TSTD device which is a component of a BS and an MS in a mobile communication system utilizing TSTD methods according to an embodiment of the present invention;

FIG. 3 is a block diagram of a TSTD transmitter in the BS for transmitting signals through two antennas according to an embodiment of the present invention;

FIG. 4 is a block diagram of a TSTD receiver in the MS for receiving a TSTD signal according to an embodiment of the present invention;

FIG. 5 illustrates the exchange of messages for controlling a TSTD mode between the BS and the MS according to an embodiment of the present invention;

FIG. 6 is a flowchart of an MS operation for setting a reception mode by exchanging messages with the MS and receiving traffic channel data;

FIG. 7 is a flowchart of a BS operation for setting a transmission mode by exchanging messages with the MS and transmitting traffic channel data;

FIG. 8A illustrates the format of a broadcast message sent to a plurality of MSs by a BS;

FIG. 8B illustrates the format of an access message sent to a BS by an MS; and

FIG. 8C illustrates the format of a common control channel (CCCH) message sent to an MS by a BS.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will be described in detail with reference to the attached drawings. It is to be noted that a detailed description of a known function or structure of the present invention will be omitted if it is deemed to obscure the subject matter of the present invention.

A detailed description of transmission and reception control message processes for a BS transmitter and an MS receiver to transmit and receive TSTD traffic channel data will be provided.

It should be appreciated with respect to the following description that a forward common channel (e.g., common control channel and common traffic channel) is a channel which can be received by all MSs in a cell, and a forward dedicated channel (e.g., dedicated control channel and dedicated traffic channel) is a channel which can be received by only one specific MS.

The present invention is intended to provide a TSTD device and method in a mobile communication system in which a BS selects one of at least two transmission antennas in time switching to send a common and/or dedicated channel signal according to a switching pattern control signal and an MS receives the TSTD signal.

The present invention is also directed to the operation of the forward common and dedicated channels when a mobile communication system supports the TSTD function as optional or requisite.

If TSTD is supported as a requisite function, all BSs and MSs in the system can communicate data with TSTD. Hence, TSTD can be applied to the forward common and dedicated channels. More specifically, TSTD is

necessarily applied to the forward common channels, and flexibly applied to the forward dedicated channels. The forward dedicated channels are communicated in a TSTD mode in a normal state but in a non-TSTD mode during a handoff or according to the status of a BS or an MS.

If TSTD is supported as an optional function, TSTD BSs and MSs may coexist with non-TSTD BSs and MSs in the system. In this case, TSTD can be applied to the forward common and dedicated channels in many ways. Since the forward common channel is shared by all MSs in a cell, an MS should be capable of receiving a TSTD signal from a BS if the next generation mobile communication standard provides that the BS should support the TSTD function. In the case of the forward dedicated channel, TSTD is applied if both a BS and an MS can support TSTD and is released when the BS or the MS considers non-TSTD mode communication necessary as in a handoff. If at least one of the BS and the MS does not support the TSTD function, TSTD cannot be applied to the forward dedicated channel.

A description of operation of the forward common and dedicated channels between a BS having the TSTD function as optional and an MS having the TSTD function as requisite will precede a description of operation of the forward common and dedicated channels between a BS and an MS which have the TSTD function as requisite. Since reception of a TSTD signal from a BS indicates reception of signals from different paths according to a TSTD transmission pattern of the BS, it is preferable to set a reception pattern to be the same as the transmission pattern and estimate a channel.

FIGs. 1A and 1B describe a TSTD operation in a mobile communication system having TSTD as an optional function according to an embodiment of the

present invention. FIG. 1A illustrates channel support/non-support for the situation where the BS supports TSTD, and FIG. 1B illustrates channel support/non-support for the situation where the BS does not support TSTD. FIGs. 1A and 1B show that application of TSTD to forward channels including a BCCH (Broadcast Control Channel), a CCCH (Common Control Channel), and a TCH (Traffic Channel) depends upon whether a BS and an MS support TSTD or not. Shaded blocks indicate those channels which support TSTD. For example, referring to FIG. 1A, it is shown that the TCH channel supports when both the BS and MS support TSTD.

The forward channels, briefly described above, are defined as follows. BCCH is a common channel on which a BS broadcasts the same information to a plurality of MSs, the CCCH is a common channel on which a BS sends a specific MS a paging message, a channel assignment message, and the like, and the TCH is a dedicated channel on which a BS sends a specific MS user information or signalling information. An RACH (Random Access Channel) (not shown) is a reverse access channel on which an MS transmits data to a BS.

In the case where TSTD BSs and MSs coexist with non-TSTD BSs and MSs, the transmission mode of each transmission channel (i.e., BCCH, CCCH, TCH) for a BS is set according to the operational modes of the BS and an MS, as described in Table 1:

(1) when both the BS and the MS support TSTD, TSTD is applied to a forward BCCH. Though TSTD is basically not applied to other common control channels, it can be applied to them during a time period assigned to an MS in a limited way when necessary in the system. TSTD is selectively applied to the forward dedicated channel.

(2) when only the BS can support TSTD, TSTD is not applied to all forward channels.

(3) when only the MS can support TSTD, TSTD is not applied to all forward channels.

(4) when either of the BS and MS cannot support TSTD, TSTD is not applied to all forward channels.

First Embodiment: BS and MS Support TSTD

In accordance with one embodiment of the present invention where both the BS and MS support TSTD (See FIG. 1A, LHS). TSTD is applied to forward channels only if both the BS and the MS support TSTD in a mobile communication system having TSTD as an optional function.

Though the forward BCCH is directed to unspecific MSs in a cell, if all corresponding MSs can receive a TSTD signal, it is preferable that the BS transmit the forward BCCH in TSTD. The forward CCCH, received by a plurality of MSs, is considered a channel temporarily designated as dedicated for transmission of data to a specific MS during a predetermined time period. Therefore, TSTD is selectively applied to the forward CCCH.

A TSTD device for controlling a TSTD operation in a mobile communication system must be incorporated as additional hardware in both a BS 10 and an MS 12 in FIG. 2.

Referring to FIG. 2, the BS 10 is comprised of a BS transmitter 14 for sending a broadcast message, a paging message, and traffic data (voice, data, and signalling) on a BCCH, a CCCH, and a TCH, upon receipt of a control signal from a BS controller , a BS receiver 16 for receiving a message from the MS 12

signal or a synchronization providing channel from the BS transmitter 14 and synchronizes its timing to the BS 10, in step 702 of FIG. 7. In step 704, the MS 12 receives information about the BS 10 on the BCCH. The information includes the TSTD mode information. In steps 504 of FIG. 5 and 706 of FIG. 7, the MS transmitter 22 sends the BS receiver 16 the access message on the RACH as shown in FIGs. 2 and 8B. The MS 10 register with the BS 10, MS (i.e., reception mode) by sending access message on the RACH to register with the BS10, and notifies the BS 10 of information about the MS 12 through this registration procedure (See FIG. 8b). The RACH message includes the TSTD mode information.

Then, the BS controller 18 and the MS controller 24 analyze the access message and the broadcast message, respectively, to determine whether a TSTD communication is possible. If such a communication is possible, the BS 10 and the MS 12 perform a traffic channel set-up in step 506 of FIG. 5 and control their respective TSTD transmitter and receiver of FIGs. 3 and 4 in response to TSTD switching pattern control signals determined in a determined operation mode. The determined operation mode will be described in more detail below.

The BS controller 18 analyzes the reception mode of the MS 12 on the RACH in step 604 of FIG. 6, and determines whether a TCH assignment request was received from the MS on the RACH in step 606 of FIG. 6. Upon receipt of a TCH assignment request from the MS 12, the BS controller 18 proceeds to step 608. Otherwise, the BS controller 18 awaits a TCH assignment request on the RACH.

In step 608, upon receiving a TCH assignment request, the BS controller 18 determines whether the TCH can be assigned. If there is an available TCH,

the BS controller 18 assigns the TCH and notifies the MS 12 of a TSTD pattern by sending the MS 12 the message of FIG. 8C on the CCCH. The CCCH message may include the TSTD mode change information and TSTD pattern information. Here, the TSTD mode change information is a field indicating the TSTD mode is changed to a non-TSTD mode when the BS does not want to use the TSTD mode. The TSTD pattern field provides a TSTD pattern in which data is switchedly transmitted through the antennas ANT1 and ANT2 by the BS 10. The TSTD mode change field and the TSTD pattern field are optional.

In step 612, the BS controller 18 determines whether the MS 12 is set to a TSTD reception mode from the reception mode field of the received RACH message. If the MS 12 is in the TSTD mode, the BS controller 18 provides a control signal to the first switch controller 112 based on one of default pattern information, the TSTD pattern information sent to the MS 12 on the CCCH, or pattern information determined by the ESN (Electronic Serial Number) of the MS 12, and sends the TCH in the TSTD mode. Here, it is assumed that there is no TSTD mode change. The first switch controller 112 controls the outputs of the first and second switches 110 and 111 according to the switching pattern control signal received from the BS controller 18 to time-switch the I- and Q-channel data received from the spreader 108 through the antennas ANT1 and ANT 2 as indicated by reference numerals 115 and 117 of FIG. 3. It should be understood that the TSTD pattern is varied according to the switching pattern information.

In step 616, the BS controller 18 determines whether the TCH is released during transmission. If the TCH is released, the BS controller 18 returns to step 606. If the MS 12 is not set to the TSTD reception mode in step 612, the BS controller 18 sends the TCH to the MS 12 in a non-TSTD mode in step 618.

WHAT IS CLAIMED IS:

1. A TSTD (Time-Switched Transmission Diversity) controlling method in a mobile communication system having a base station (BS) which transmits forward common and dedicated channel data through at least two antennas, the method comprising the steps of:

sending a message indicating a TSTD/non-TSTD transmission mode by the BS to a plurality of mobile stations (MSs) in the coverage area of the BS through an antenna; and

analysing the message received from the BS and setting a reception mode to a TSTD/non-TSTD mode according to the transmission mode by each MS.

2. The method of claim 1, wherein the forward common channels are a broadcast control channel (BCCH) and a common control channel (CCCH).

3. A TSTD controlling method in a mobile communication system having a BS and a plurality of MSs in the coverage area of the BS, comprising the steps of:

selectively sending forward common channel which includes a message indicating a TSTD/non-TSTD transmission mode in TSTD through at least two antennas by the BS; and

analysing the forward common channel message received from the BS and setting a reception mode to a TSTD/non-TSTD mode according to the transmission mode by an MS in the coverage area of the BS.

4. The method of claim 3, wherein the forward common channel is a BCCH.

5. A TSTD controlling method in a mobile communication system which includes a BS for transmitting on forward BCCH, CCCH, and TCH (traffic channel) and a plurality of MSs for transmitting on a reverse access channel, comprising the steps of:

sending a broadcast message indicating a transmission mode on the BCCH to the MSs by the BS;

sending the BS an access message indicating a reception mode on the reverse access channel in response to the broadcast message by the Mss; and

sending traffic channel data in TSTD by the BS if the reception mode information received on the reverse access channel indicates a TSTD mode.

6. The method of claim 5, wherein the BCCH and the CCCH are sent through at least one antenna.

7. A TSTD controlling device in a mobile communication system which includes a BS and an MS which have at least two different channels and communicate a control message on the channels, comprising:

a BS device having a controller for generating a switching control signal having a specific pattern when an MS reception mode is a TSTD mode, to transmit data in TSTD by sequentially switching at least two antennas without an overlap in time; and

an MS device having a reception switch for switching in response to the switching control signal when a BS transmission mode is a TSTD mode.

8. The device of claim 7, wherein the specific pattern is determined by the unique number of the MS.

9. The device of claim 8, wherein the specific pattern is a switching

pattern determined by the BS and the MS determines a reception switching pattern by receiving the switching pattern on a common control channel.

10. The device of claim 7, wherein the BS device further includes a transmitter for transmitting a message indicating a transmission mode on a BCCH which is used to send common information to a plurality of MSs.

11. The device of claim 7, wherein the MS device sends the BS reception mode information on a reverse access channel when the MS detects TSTD information from the broadcast message received from the BS on a common control channel.

12. The device of claim 7, wherein the BS device sets a TSTD mode for the transmitter according to the message indicating the MS reception mode received on the reverse access channel.

13. A TSTD controlling device in a mobile communication system having a TSTD function, comprising:

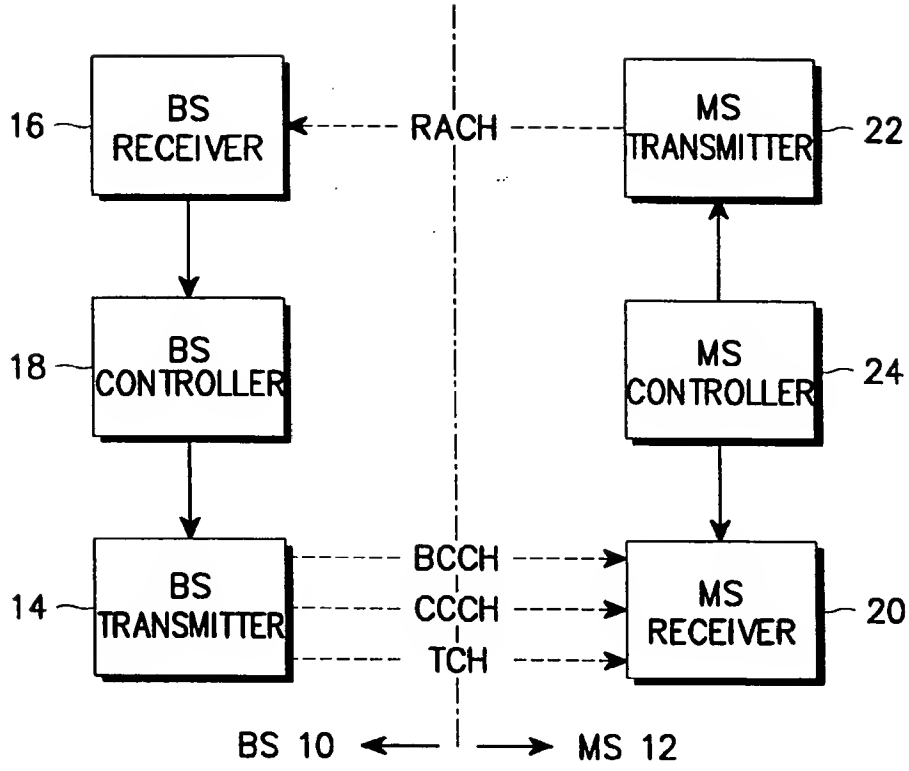
a BS device for transmitting a forward common channel in TSTD; and

an MS device for receiving the forward common channel in TSTD.

14. The device of claim 13, wherein the forward common channel is a broadcast channel.

15. The device of claim 13, wherein the forward common channel is a synchronization providing channel.

16. A TSTD controlling method in a mobile communication system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BS RECEIVER
RACH
MS TRANSMITTER
22
18
BS CONTROLLER
MS CONTROLLER
24
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BS TRANSMITTER
BCCH
CCCH
TCH
MS RECEIVER
20
BS 10
MS 12

FIG. 2

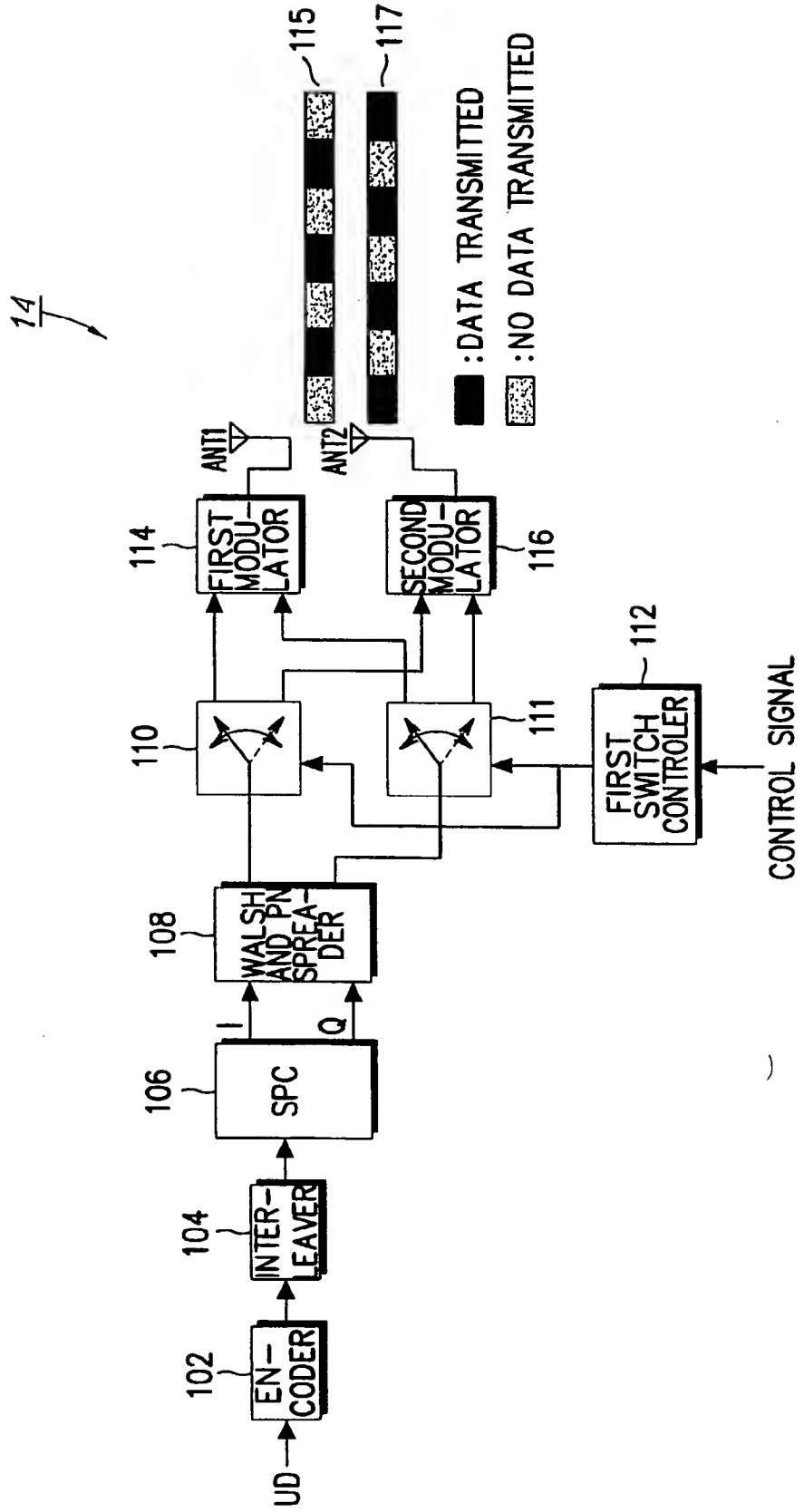
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FIG. 3

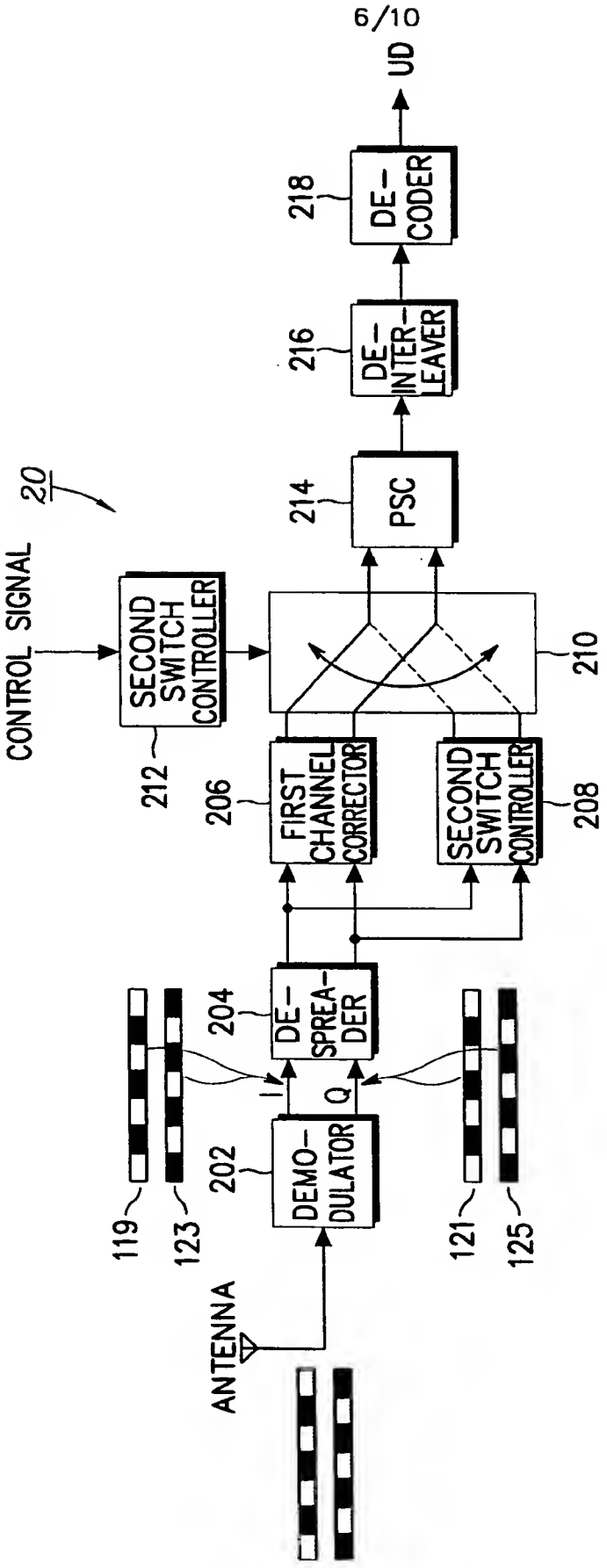
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FIG. 4